Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Central and Arctic Region
Canadian Science Advisory Secretariat
Science Advisory Report 2013/031

ASSESSMENT OF NORTHERN SHRIMP (*Pandalus borealis*) AND STRIPED SHRIMP (*Pandalus montagui*) IN THE EASTERN AND WESTERN ASSESSMENT ZONES (SHRIMP FISHING AREAS 2 AND 3)

Top: Northern Shrimp (Pandalus borealis) Bottom: Striped Shrimp (Pandalus montagui) Photo: Fisheries Oceans Canada, Newfoundland and Labrador Region.

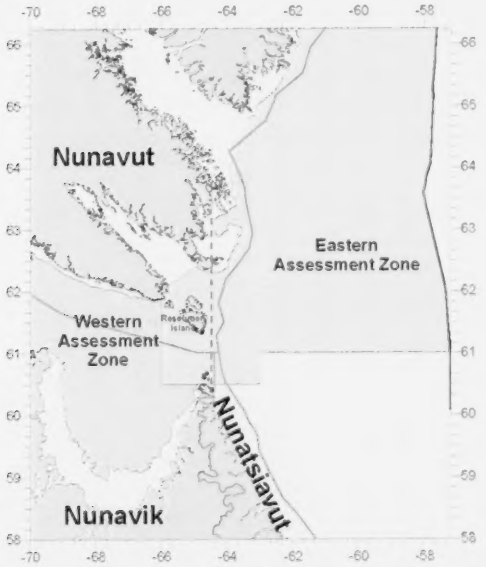

Figure 1. Eastern and Western assessment zones which underlay Shrimp Fishing Area 2 (east of blue dashed line) and 3 (west of blue dashed line). Boundaries of the Nunavut, Nunavik and Nunatsiavut land claims are shown in red.

Context:

*Fisheries and Oceans Canada (DFO) Resource Management (RM) has requested Science advice on the status of the two species of shrimp, Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the waters adjacent to Nunavut. Both species in the Eastern Assessment Zone were last assessed in 2011 (DFO 2011) and updated in 2012 (DFO 2012). For the Western Assessment Zone both species were last assessed in 2010 (DFO 2010) and updated in 2012 (DFO 2012). Assessments are planned every two years with monitoring updates in the intervening years.*

Although at the time of the current assessment changes to the management of the shrimp fishery in Shrimp Fishing Areas 2 and 3 have been approved by the Minister and co-management boards, they will not come into effect until the 2013/14 fishing season. However, this approval formalizes the Eastern and Western Assessment Zones adopted at the 2011 zonal science advisory process (ZAP) (DFO 2011) as the basis for setting Total Allowable Catch (TAC) for each species within these zones.

This assessment follows the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007a). A series of fishery-independent surveys and fishery data formed the basis of the current assessment. Since the 2012 update (DFO 2012), new survey data are only available for the Eastern Assessment Zone. For the Western Assessment Zone advice from the 2012 monitoring update (DFO 2012) was brought forward and updated with new fishery information so that all current advice is in this document.

SUMMARY

- The thermal regime in the Eastern Assessment Zone has moderated from the higher temperatures of 2010 and 2011 down to the levels seen during the first four years of the survey. There are no new survey data for the Western Assessment Zone and the advice from the 2012 update corresponding to these data was carried forward. The assessment includes the fishery data since the 2012 update.
- Since the 2012 update, one Northern Shrimp Research Foundation – Fisheries and Oceans Canada survey of Shrimp Fishing Area 2 Exploratory and Resolution Island Survey Area provided the fishery-independent data for this assessment.
- Survey biomass, fishery data, and fishery exploitation rate indices are used to assess *Pandalus borealis* and *Pandalus montagui*.

Eastern Assessment Zone – *Pandalus borealis*

- Total catches (directed and by-catch) of *Pandalus borealis* varied without trend at about 6,000 t for 1997 through 2009/10. Increases in catch in the 2010/11 and 2011/12 fishing season mainly came from increased effort and catch in the Shrimp Fishing Area 2 east of 63°W. Catch statistics in 2012/13 are not fully available but it is unlikely the Total Allowable Catch will be taken.
- The fishable biomass index ranged from 51,000 – 79,000 t from 2008 – 2012 averaging about 68,000 t. Female spawning stock biomass index ranged from 28,000 – 48,000 t averaging about 40,000 t for the same period. The 2012 fishable biomass index was 60,000 t and female spawning stock biomass index was 41,000 t.
- Recruitment prospects are uncertain.
- The observed exploitation rate index has varied without trend since 2007/08 around a mean of 9%. The catch was well below the Total Allowable Catch. Based on the 2012/13 Total Allowable Catch of 9,150 t the potential exploitation rate would be 15%.
- Under the Integrated Fisheries Management Plan Precautionary Approach Framework, the female spawning stock biomass index for the Eastern Assessment Zone remains within the Healthy Zone for 2012/13.

Eastern Assessment Zone – *Pandalus montagui*

- The catch declined steadily from about 4,000 t in 1999 to about 135 t in 2011/12, then increased to 656 t in 2012/13. The decline is thought to be a consequence of changes in fishing patterns, market conditions, and alternative fishing opportunities. The increase in 2012/13 is mainly from renewed fishing effort in the Nunavik Marine Region.
- The fishable biomass index ranged from 7,400 – 29,000 t from 2008 – 2012 averaging about 15,000 t. Female spawning stock biomass index ranged from 5,800 – 24,000 t averaging about 10,000 t for the same period. The 2012 fishable biomass index was 29,000 t and female spawning stock biomass index was 24,000 t. It is not possible that the biomass increase resulted from local growth.
- Recruitment prospects are uncertain.
- The observed exploitation rate index has varied without trend from 2007/08 through 2011/12 around a mean of 6%. The exploitation rate for 2012/13 is uncertain because of concerns raised about the biomass estimate.

- The female spawning stock biomass index in the Eastern Assessment Zone had been declining into the Cautious Zone and approaching the Limit Reference Point in 2011/12. Although the sharp increase in the female spawning stock biomass index in 2012 has moved it back into the Healthy Zone well above the Upper Stock Reference, concerns about the biomass estimate suggest caution.

Western Assessment Zone[1] – *Pandalus borealis*

- Observer records reported catches of 60 t of *Pandalus borealis* in 2010/11, 0 t in 2011/12, and 6 t in 2012/13.
- In 2011, the *Pandalus borealis* fishable biomass index was 19,700 t and female spawning stock biomass index was 6,400 t similar to previous surveys.
- Reference points were developed for the Precautionary Approach Framework. Upper Stock Reference (3,400 t) was defined as 80% and the Limit Reference Point (1,300 t) was defined as 30% of the geometric mean of the spawning stock biomass for the three surveys. These will be re-evaluated when additional data become available.
- The female spawning stock biomass index for the Western Assessment Zone places the resource in the Healthy Zone of the Precautionary Approach Framework. The 1,500 t Total Allowable Catch for the Western Assessment Zone for the 2013/14 fishing season will result in a potential exploitation rate of 8% if the biomass observed in the 2011 survey is unchanged in 2013.

Western Assessment Zone[1] – *Pandalus montagui*

- Observer records reported catches of 300 t of *Pandalus montagui* in 2010/11, 840 t in 2011/12, and 1,300 t in 2012/13.
- In 2011, the *Pandalus montagui* fishable biomass index was 71,500 t and female spawning stock biomass index was 32,500 t similar to previous surveys.
- Reference points were developed for the Precautionary Approach framework. Upper Stock Reference (18,000 t) was defined as 80% and the Limit Reference Point (6,700 t) was defined as 30% of the geometric mean of the spawning stock biomass for the three surveys. These will be re-evaluated when additional data become available.
- The female spawning stock biomass index for the Western Assessment Zone places the resource in the Healthy Zone of the Precautionary Approach Framework. The 5,000 t Total Allowable Catch for the Western Assessment Zone for the 2013/14 fishing season will result in a potential exploitation rate of 7% if the biomass observed in the 2011 survey is unchanged in 2013.

BACKGROUND

Species Biology

Northern Shrimp (*Pandalus borealis*) is found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, and Striped Shrimp (*P. montagui*) is found from Davis Strait south to the Bay of

[1] The Western Assessment Zone was not assessed at the February 2013 zonal assessment process because there were no new survey data. Advice from the 2012 Monitoring Update for the area corresponding to the new Western Assessment Zone was carried forward, updated with new fishery data and reference points developed.

Fundy. Both species have preferred depth and temperature distributions. *P. montagui* prefers cooler water (-1 to 2°C) than *P. borealis* (0 to 4°C). These cooler waters tend to occur in shallower depths. The main density of *P. borealis* tends to occur at 300 – 500 m while *P. montagui* occur mainly in 200 – 500 m. Northern Shrimp are associated with soft substrates whereas Striped Shrimp prefer harder bottoms.

Both species of shrimp are protandric hermaphrodites, functioning as males early in their lives then changing sex and reproducing as females for the remainder of their lives. Females usually produce eggs once a year in the late summer-fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Newly hatched shrimp spend three to four months as pelagic larvae. At the end of this period they move to the bottom and take up the life style of the adults. Both species migrate into the water column during the night. The migration consists mainly of males and smaller females. Shrimp are opportunistic feeders on or near the sea floor and in the water column. Shrimp ageing is uncertain but shrimp in the north are thought to live five to eight years. Growth rates and maturation are likely slower in northern populations. *Pandalus* shrimp are important forage species.

Fishery

The fishery is managed by Total Allowable Catch (TAC). Access to the fishery is limited to 17 offshore license holders and to Nunavut with special quota allocations to the Nunavut Wildlife Management Board (NWMB) to be fished within the Nunavut Settlement Area. The NWMB sub-allocates its quota to Hunters and Trappers Organizations and other Nunavut interests. All fishing to date has been conducted by large vessels with 100% observer coverage.

Fishing gear consists of single and, more recently, twin shrimp trawls requiring a minimum codend mesh size of 40 mm and Nordmøre separator grate (maximum 28 mm bar spacing). Since 2003, the management year has been 1 April to 31 March. The fishing season is limited by the extent of sea ice, and is conducted between May and December in most years.

P. borealis has been the main commercial species throughout the history of the shrimp fishery in this area. Historically most of the harvest of *P. montagui* occurred as by-catch in the directed *P. borealis* fishery. Directed fishing for *P. montagui* has become more important in recent years within Shrimp Fishing Area (SFA) 3.

The fishery began in the late 1970s in SFA 1. Exploratory fishing expanded into northern SFA 2 and then to areas southeast of Resolution Island in Hudson Strait. Quotas in these areas were based on fishery performance and not scientific survey data. In the mid-1990s, the fishery moved southeast of Resolution Island in SFA 2, where the main fishery remains to date. Implementation of the Nunavut Land Claims Agreement in 1999 shifted the main fishery east of the Nunavut Settlement Area. Over the last ten years, the distribution of fishing effort has remained unchanged.

Fishery CPUE is not considered to reflect stock status. Commercial fishing locations are not broadly distributed; captains select areas of high density. A mix of two shrimp species is targeted in the fishery and the composition of the two species in the catch determines which species is designated as directed which biases CPUE calculations. Over the time period of the fishery, economic factors (e.g., fuel prices, price of shrimp) have influenced when and where the species are caught. Captains have learned over the years to target each species to achieve cleaner catches of one species over the other.

ASSESSMENT

This is an assessment of both *P. borealis* and *P. montagui* in the Eastern and Western Assessment Zones (Fig. 2). These two species have overlapping distributions, especially in the Resolution Island area, resulting in an overlap of their fisheries. The total removal, both directed catch and by-catch, of each species is considered in the assessment.

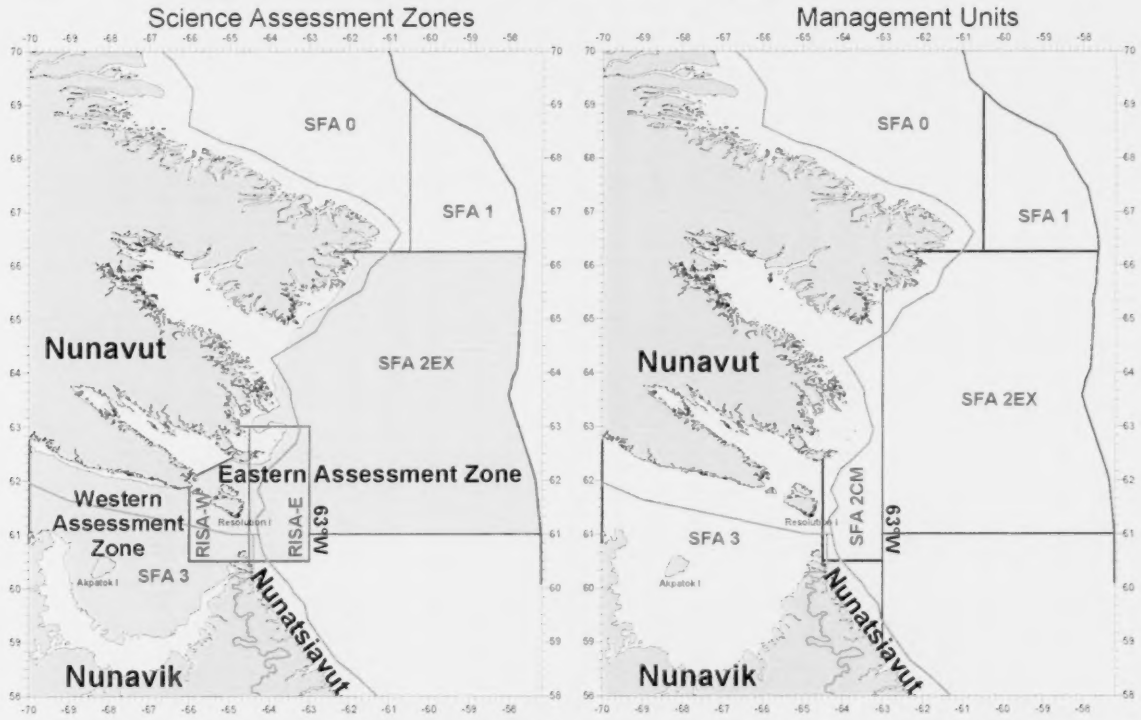

Figure 2. Location of the six survey areas (left panel) and the five management units (right panel) mentioned in this Science Advisory Report. SFAs 0 and 1 were not included in this assessment. SFA 1 is part of the straddling Greenland shrimp stock which Canada shares with Greenland. It is assessed annually by the Northwest Atlantic Fisheries Organisation. No new information was available for SFA 0. Boundaries of the Nunavut, Nunatsiavut and Nunavik Land Claim Areas are identified with red lines. Shrimp Fishing Area (SFA), Commercial (CM), Exploratory (EX), Resolution Island Study Area (RISA), East (E), West (W).

New survey data considered in this assessment comes from the 2012 NSRF–DFO survey of the Eastern Assessment Zone (RISA-W, RISA-E and SFA 2EX survey areas, Fig. 2). Survey data are available for the period of 2006–2012 however the first two years are not considered comparable with the rest of the series because of incomplete coverage and operational issues so only 2008–2012 data are evaluated.

For the Western Assessment Zone no new fishery-independent data are available for this assessment. The results and advice (DFO 2012) are brought forward unchanged and updated with new fishery data. This was done so that all current advice for both zones is available in a single document and to develop Precautionary Approach Reference Points for both species based on this current assessment.

The assessment follows the framework established by DFO (2007a). Fishable and female spawning stock biomass (SSB) indices from scientific surveys form the basis of the assessment. Fishable biomass is based on male and female shrimp from the surveys with a carapace length

greater than 17 mm. SSB is based on all female shrimp from the surveys regardless of size. The recruitment index is based on the abundance of shrimp from 11.5 to 17 mm carapace length. An acceptable method to calculate total instantaneous mortality (Z) has not been found and therefore was not included as part of the assessment. Fishery data are used to determine observed exploitation rate index as catch from observer records divided by the fishable biomass index from the same year. The potential exploitation rate index was calculated assuming the entire TAC was taken. Bootstrapped 95% confidence intervals are included for each of the indices.

For this assessment, population status was evaluated within the Precautionary Approach (PA) framework (DFO 2006). Reference points (RP) were developed for shrimp (DFO 2009) and implemented in the Integrated Fisheries Management Plan (IFMP) (DFO 2007b). Proxies for the RPs were based on the geometric mean of SSB. The Limit Reference Point (LRP) is 30% of the mean and the Upper Stock Reference (USR) is 80% of the mean. Reference points for the Western Assessment Zone were developed with the same proxies.

The Western Assessment Zone was surveyed with the Greenland Institute of Natural Resources' research vessel Paamiut using a Cosmos trawl. The Eastern Assessment Zone was surveyed with the commercial fishing vessel Cape Ballard from 2005 to 2011 using a Campelen trawl. The standard Campelen was used for the whole Zone in 2006 and 2007, the standard trawl was used in SFA 2EX in 2008 but a Campelen trawl with modified footgear was used in RISA. From 2009 onward the Campelen with modified footgear was used in the whole Zone. In 2012, the Cape Ballard was replaced with the fishing vessel Aqviq using the same survey protocols and gear.

An added complication when interpreting the trawl survey data is the strong tidal currents in Hudson Strait, up to five knots, which could result in quick shifts in shrimp distribution and catchability.

Eastern Assessment Zone – *P. borealis*

Fishery

Since 1994, the majority of catch taken in the Eastern Assessment Zone has come from SFA 2 southeast of Resolution Island and east of the Nunavut and Nunavik land claims borders and west of 63°W. Total catches (directed and by-catch) of *P. borealis* varied without trend at about 6,000 t for 1997 through 2009/10 (Fig. 3). Increases in catch in the 2010/11 and 2011/12 fishing seasons mainly came from increased effort and catch in SFA 2EX although the quota has never been fully taken. Since 1998, almost all of the SFA 2CM quota had been taken in most years but may not be in 2012/13. Fishing for this year has ended but the low catch reported may be due to incomplete Canadian Atlantic Quota Report (CAQR) and observer records.

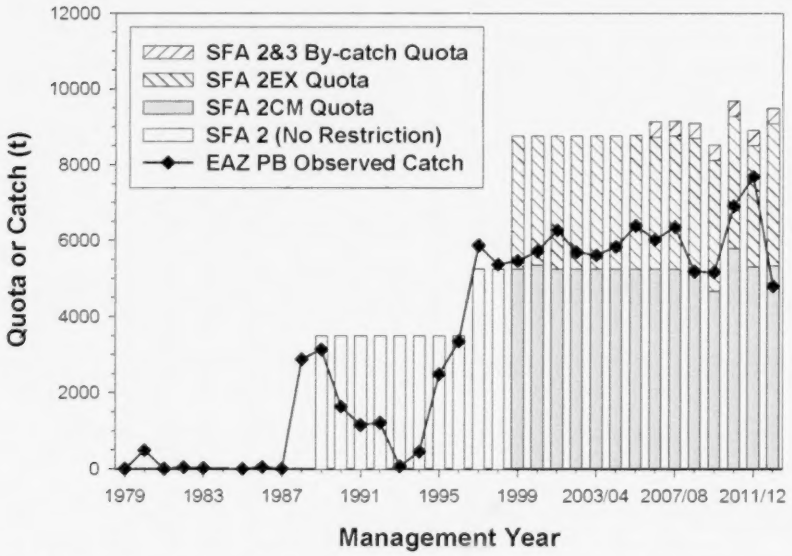

Figure 3. Eastern Assessment Zone Pandalus borealis TAC and catch recorded by the observer program. Observer catch records may be incomplete for 2012/13.

CPUE in the Eastern Assessment Zone shows an overall strong upward trend but with three plateau periods (1979 – 1995, 2000 – 2008/09, 2009/10 – 2012/13) (Fig. 4). The increase is thought to reflect changes in fishing behaviour and/or technology rather than stock status.

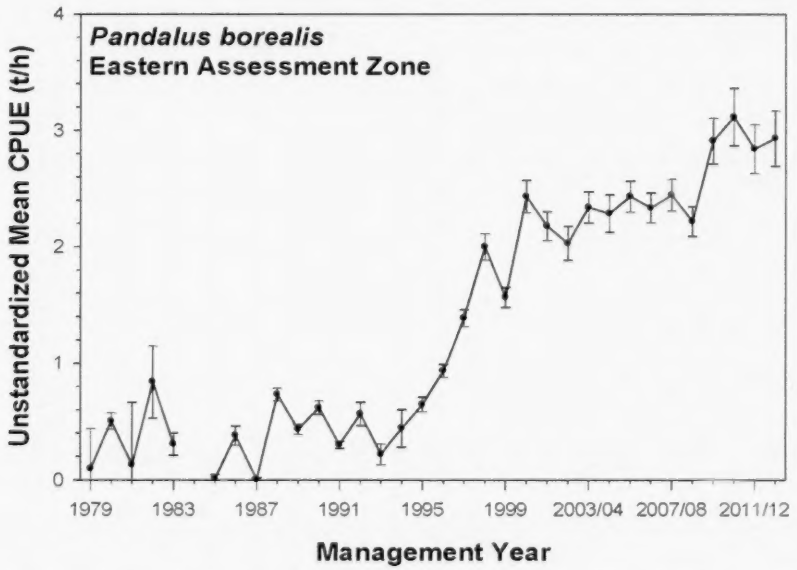

Figure 4. The unstandardized CPUE index for directed Pandalus borealis fishing in the Eastern Assessment Zone. Observer records for 2012/13 season may be incomplete. Error bars are 95% confidence intervals.

Biomass

The fishable biomass and SSB indices have not changed significantly over the period 2008–2012 (Fig. 5). The fishable biomass index ranged from 51,000 – 79,000 t from 2008 – 2012 averaging about 68,000 t. SSB index ranged from 28,000 – 48,000 t averaging about 40,000 t for the same period. The 2012 fishable biomass index was 60,000 t and SSB index was 41,000 t.

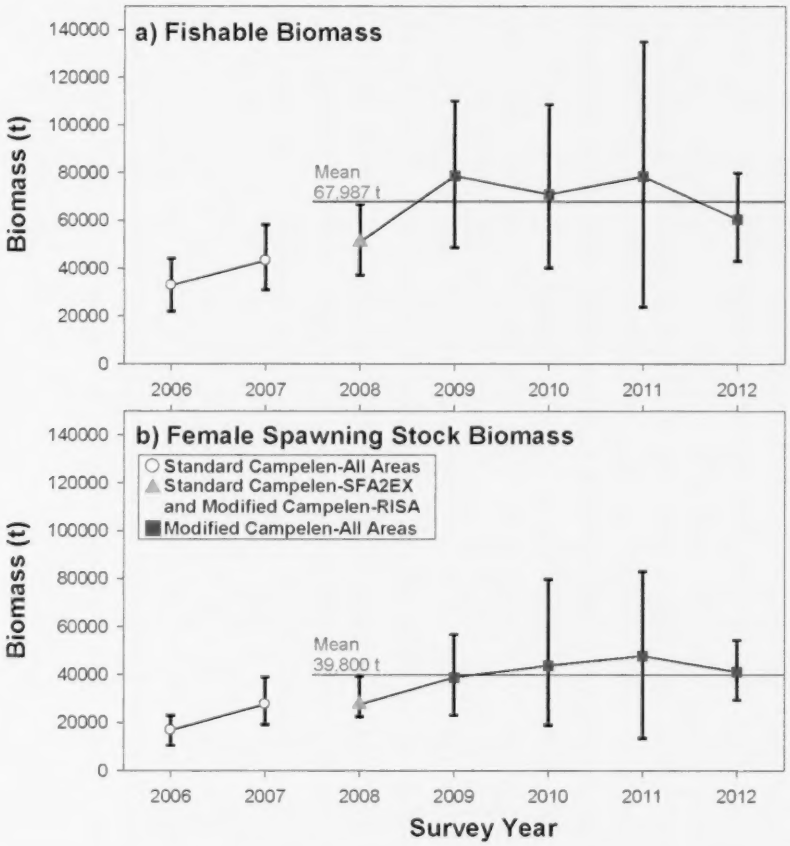

Figure 5. The Eastern Assessment Zone fishable and female spawning stock biomass indices of Pandalus borealis for the survey years 2006 – 2012. The first two years of survey data (2006 – 2007) are not considered to be comparable with the rest of series because of poor trawl performance around Resolution Island. Error bars are 95% confidence ranges.

Recruitment

Recruitment prospects are uncertain. Too few recruitment-sized shrimp are caught in the codend during the survey to produce a meaningful index.

Exploitation

Most of the fishery is concentrated in the southern portion of SFA 2CM. The observed exploitation rate index has varied without trend since 2007/08 around a mean of 9% (Fig. 6).

The catch was well below the TAC. Based on the 2012/13 TAC of 9,150 t the potential exploitation rate would be 16%.

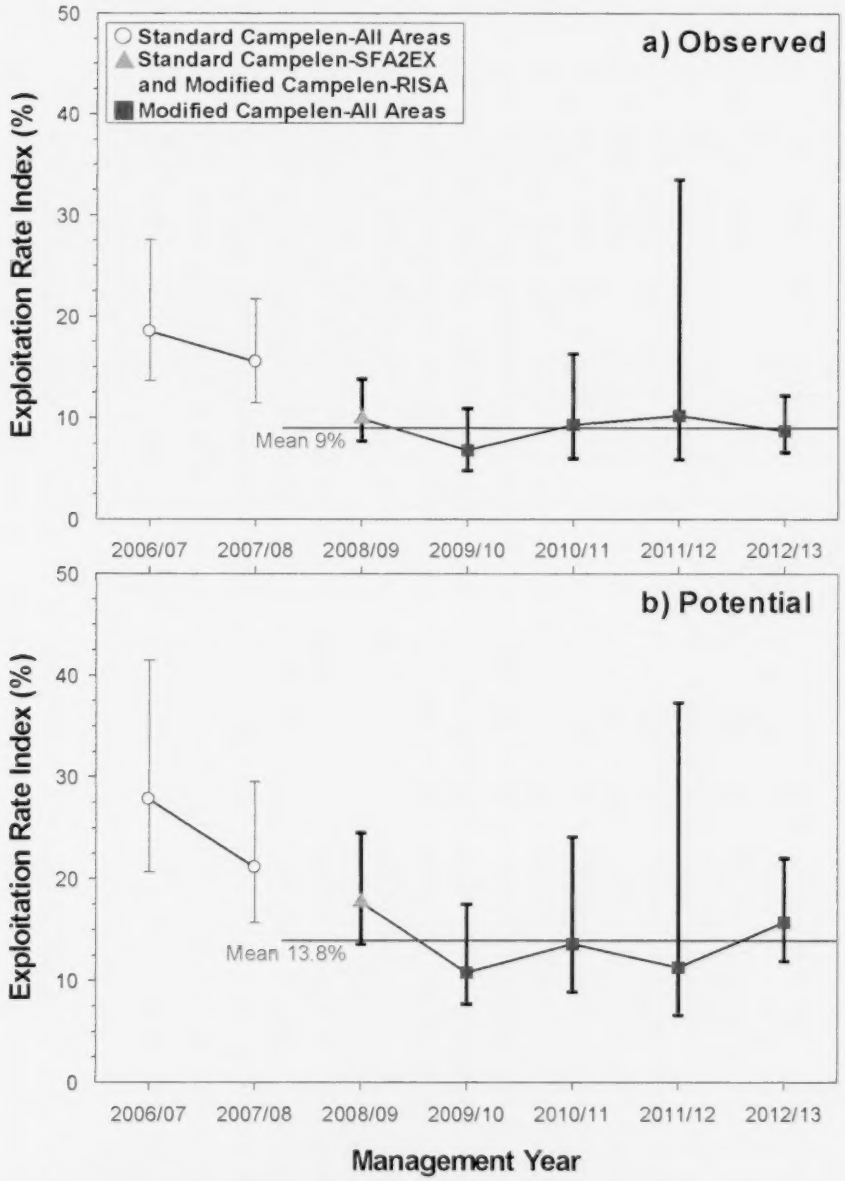

Figure 6. The Eastern Assessment Zone Pandalus borealis exploitation rate indices for a) the observed rate based on the catch taken and b) the potential rate if the TAC assigned to the Eastern Assessment Zone was taken. The first two years of survey data (2006 – 2007) are not considered to be comparable with the rest of series because of poor trawl performance around Resolution Island. Error bars are 95% confidence ranges.

Current Outlook and Prospects

The 2012/13 SSB for the Eastern Assessment Zone remains within the Healthy Zone of the IFMP PA framework (Fig. 7). The exploitation rate over the period 2008/09 – 2012/13 has averaged 9%. However the catch was well below the TAC. If all TAC had been taken in 2012/13 it would have resulted in an exploitation rate of 15%.

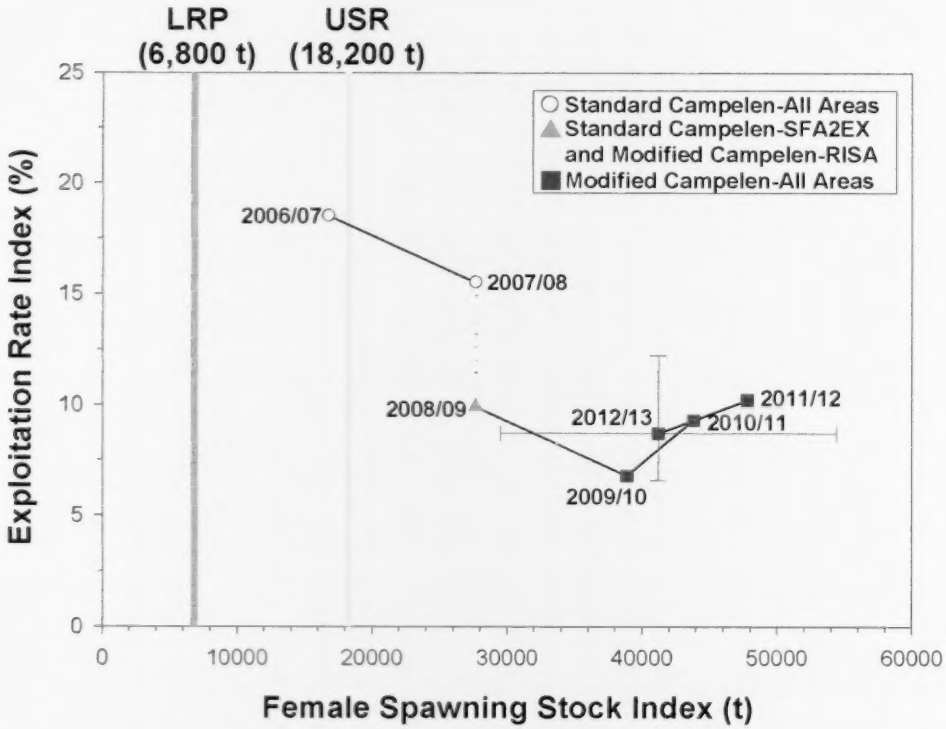

Figure 7. The Eastern Assessment Zone trajectory of Pandalus borealis female spawning stock biomass and exploitation rate in relation to its reference points. USR=Upper stock reference and LRP=limit reference point are 80% and 30% respectively of the geometric mean of the SSB index (2006 – 2008 in SFA 2). Error bars are 95% confidence ranges.

Eastern Assessment Zone – *P. montagui*

Fishery

The catch of *P. montagui* declined steadily from about 4,000 t in 1999 to about 135 t in 2011/12 (Fig. 8). Most of the catch had been taken as by-catch in the directed fishery for *P. borealis* in SFA 2CM south of 63°N. The catch increased to 656 t in 2012/13 mainly because of renewed directed fishing effort in the Nunavik Marine Region portion of the Eastern Assessment Zone where 360 t were taken. Little directed catch comes from within the Nunavut Settlement Area. The catch is taken between 63°W and 64°30'W with small amounts just over the boundary in SFA 3 but none has been taken further west than 66°W until recently.

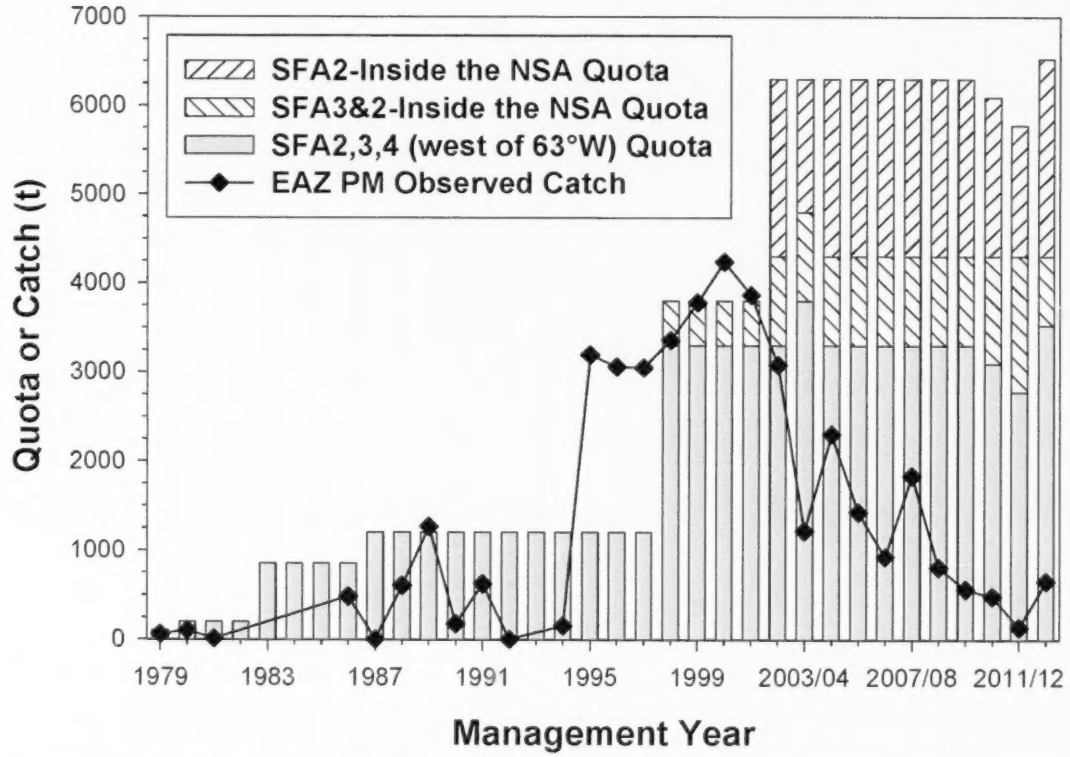

Figure 8. The Eastern Assessment Zone Pandalus montagui TAC and catch recorded by the observer program. Observer catch records may be incomplete for 2012/13.

The Nunavut Land Claims Agreement came into effect in 1999. As a result, the offshore industry was required to move operations within SFA 2CM (Fig. 2) from their traditional fishing area to east of the Nunavut Settlement Area. *P. montagui* biomass concentrations decline steeply from west to east in SFA 2 as reflected in the fishery catches. Also, captains have reported that they have learned to reduce by-catch of *P. montagui* in the directed *P. borealis* fishery. The decline in catch may also be a consequence of changes in market conditions and other fishing opportunities since 1999. Therefore, CPUE in the Eastern Assessment Zone is not considered to reflect fishery performance (Fig. 9).

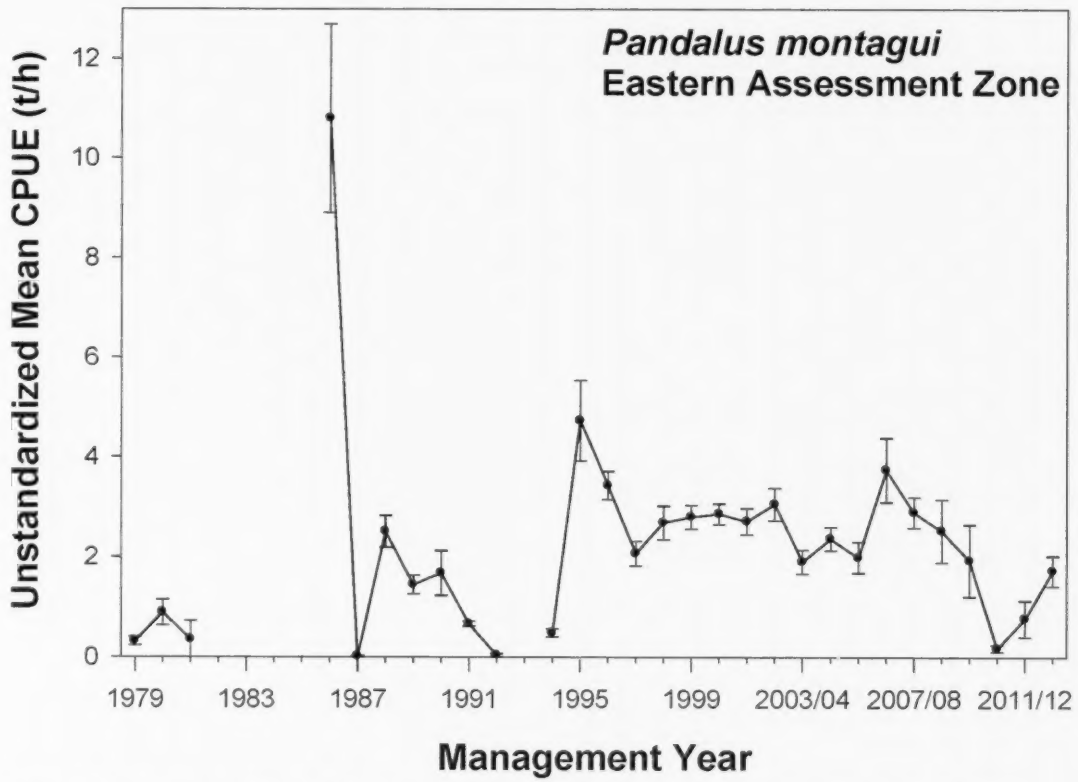

Figure 9. The unstandardized CPUE index for directed Pandalus montagui fishing in the Eastern Assessment Zone. Observer records for 2012/13 season may be incomplete. Error bars are 95% confidence intervals.

Biomass

The fishable biomass and SSB indices increased sharply in 2012 to the highest level in the time series (Fig. 10). The fishable biomass index ranged from 7,400 – 29,000 t from 2008 – 2012 averaging about 15,000 t. SSB index ranged from 5,800 – 24,000 t averaging about 10,000 t for the same period. The 2012 fishable biomass index was 29,000 t and SSB index was 24,000 t. It is not possible that the biomass increase resulted from local population growth.

The majority of this biomass is found in the western part of the zone between 64°30'W and 66°W. Warmer bottom water temperatures seen in the area in 2010 and 2011 have moderated especially in the RISA-W portion of the Zone. The biomass index increase could be an artifact of survey noise resulting from patchy distribution. The biomass increase, if real, is a result of immigration rather than population growth. The return of lower temperatures more favorable to *P. montagui* may have aided a shift in distribution, most likely from west of the Zone.

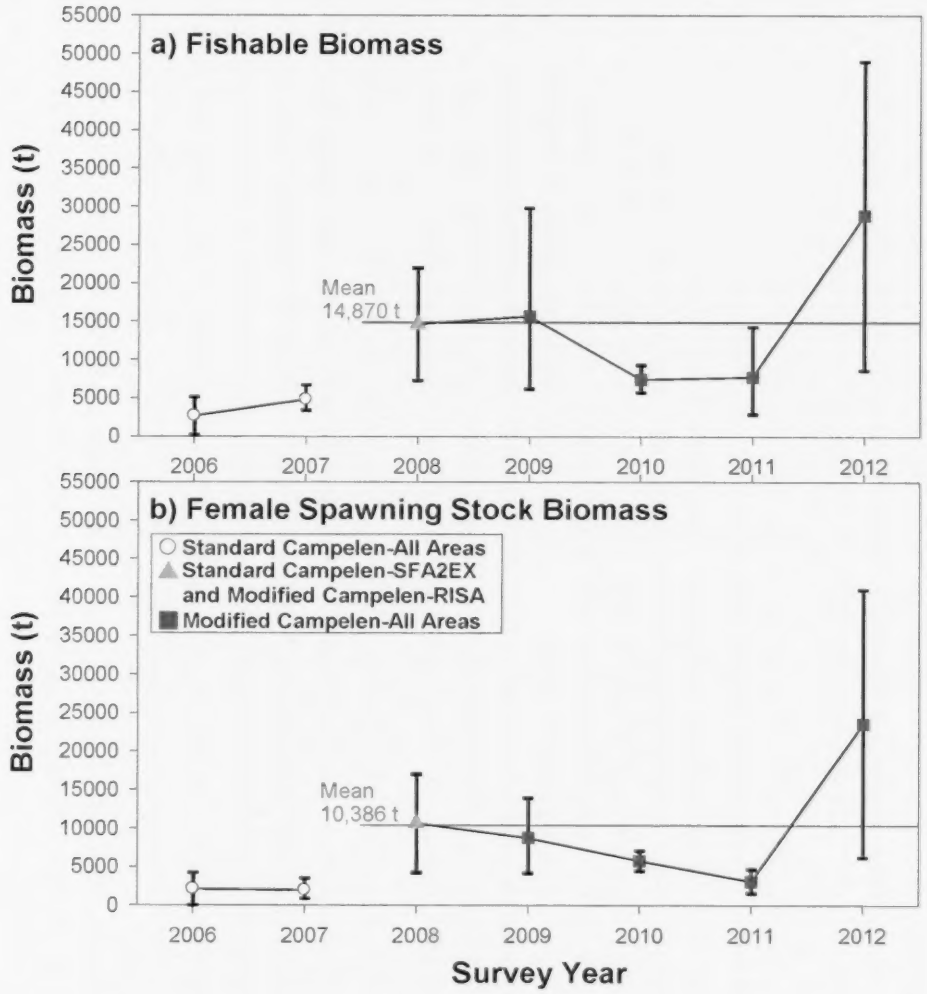

Figure 10. The Eastern Assessment Zone fishable and female spawning stock biomass indices of Pandalus montagui in the Eastern Assessment Zone for the survey years 2006 – 2012. Error bars are 95% confidence ranges.

Recruitment

Recruitment prospects are uncertain. Too few recruitment-sized shrimp are caught in the codend during the survey to produce a meaningful index.

Exploitation

Discounting the first two years of the survey, not considered comparable with the rest of the series, the observed exploitation rate index varied without trend since 2007/08 averaging 6% (Fig. 11). The potential exploitation rate index based on the TAC has varied without trend since 2007/08 around a mean of 52%. The exploitation rates for 2012/13 are uncertain because of concerns raised about the biomass estimate.

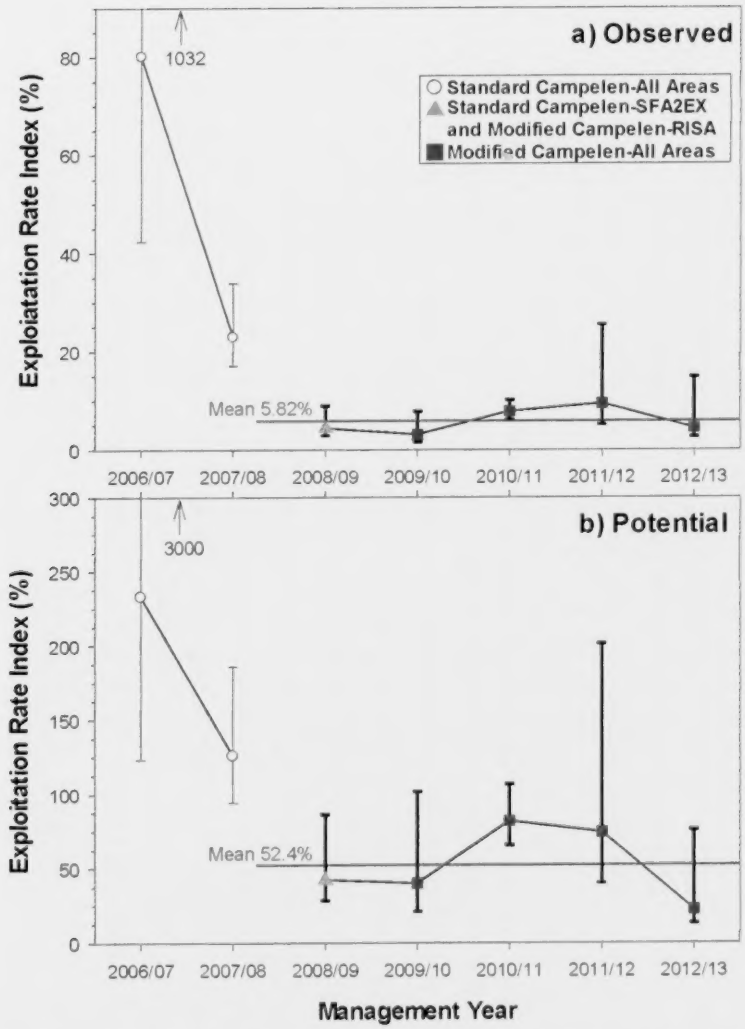

Figure 11. The Eastern Assessment Zone Pandalus montagui exploitation rate indices for the a) observed rate, based on the catch taken and the b) potential rate if the TAC was taken. Error bars are 95% confidence ranges. Upper confidence limit for 2006/07 is shown numerically.

Current Outlook and Prospects

The SSB index in the Eastern Assessment Zone had been declining in the Cautious Zone and approaching the Limit Reference Point in 2011/12 (Fig. 12). Although the sharp increase in the SSB index in 2012 has moved it back into the Healthy Zone well above the Upper Stock Reference, concerns about the biomass estimate suggest caution.

If the 2012/13 TAC had been taken, the exploitation rate would have been 23%. The reduced TAC of 2,250 t that has already been set for the 2013/14 fishing season will reduce the potential exploitation rate to 8% if the fishable biomass level observed in 2012 remains the same in 2013.

The 2010 ZAP produced a set of reference points (DFO 2010) for the SFA 2, 3, 4 quota area between 63°W and 66°W (Fig. 12). However, since the assessment area has changed and

given the short survey time series which included two years of data not considered comparable, another set of reference points may need to be developed for the Eastern Assessment Zone. Some consideration, both by Science and RM, should be given to the minimum time series required to set appropriate reference points.

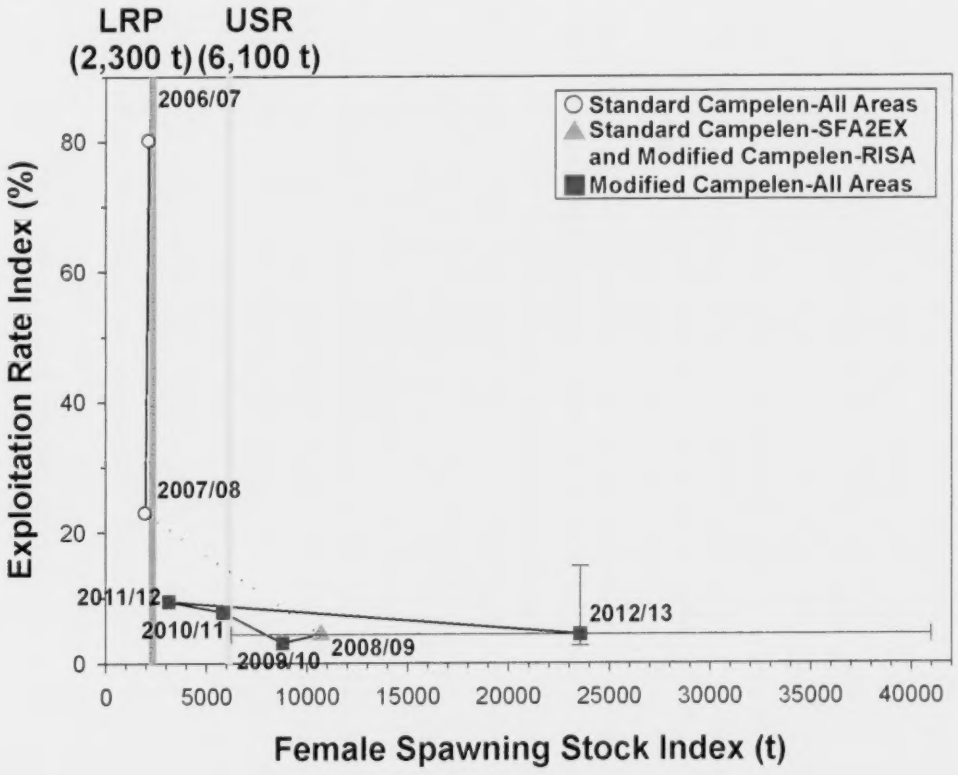

Figure 12. The Eastern Assessment Zone trajectory of Pandalus montagui female spawning stock biomass and exploitation rate in relation to its reference points. USR=Upper stock reference and LRP=limit reference point are 80% and 30% respectively of the geometric mean of the SSB index (2006-2008 in SFA 2). Error bars are 95% confidence ranges.

Western Assessment Zone – *P. borealis*

Fishery

The Western Assessment Zone was not fished between 1991 and 2010/11. The 2007, 2009 and 2011 research survey results renewed interest in fishing the area. The fishing took place in Hudson Strait near the land claims border north of Akpatok Island. All *P. borealis* caught in the Western Assessment Zone are caught as by-catch in the directed *P. montagui* fishery which was renewed in 2010/11. *P. borealis* catches are deducted from the 400 t by-catch quota for SFA 3 and SFA 2 inside the Nunavut Settlement Area. Observer records show that there were 60 t of *P. borealis* caught in 2010/11, none reported for 2011/12 and 6 t in 2012/13.

Biomass

The fishable biomass and SSB indices have not changed significantly among the three years surveyed (Fig. 13). The mean fishable biomass index over the three surveys was about

16,600 t, while the mean SSB index was about 4,500 t. In 2011, the fishable biomass index was 19,700 t and the SSB index was 6,400 t. There was no survey in 2012.

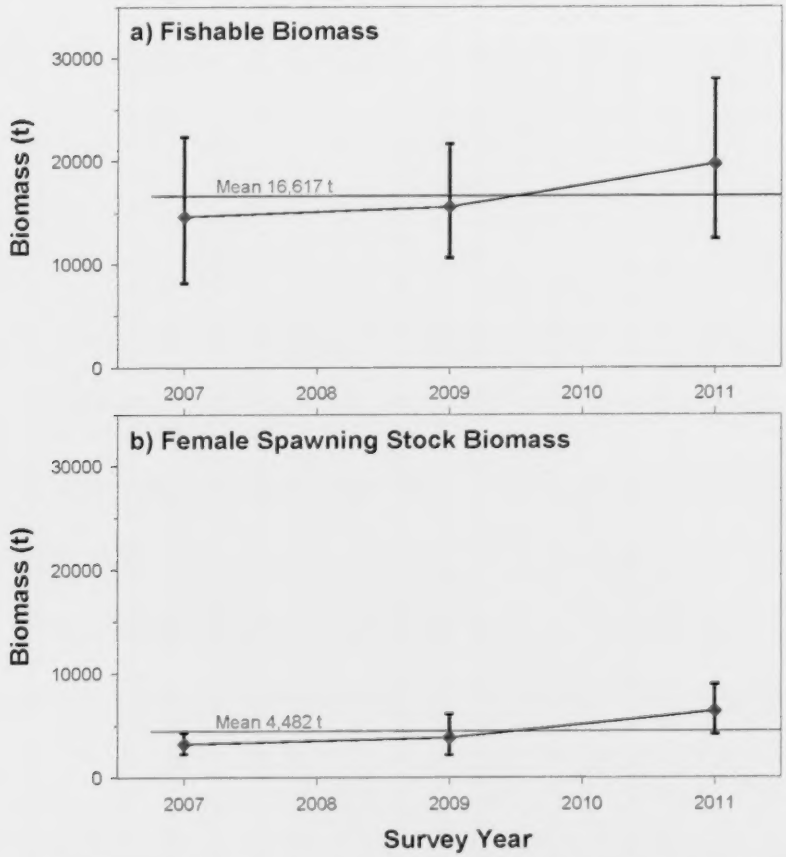

Figure 13. Western Assessment Zone Pandalus borealis, a) fishable biomass and b) female spawning stock biomass indices for the three years of DFO surveys. Error bars are 95% confidence ranges.

Exploitation

The exploitation rate was less than 1% from 2010/11-2012/13. If the entire by-catch quota was taken in the Western Assessment Zone it would result in an exploitation rate of 2-3%.

Current Outlook and Prospects

Most *P. borealis* were found in Hudson Strait north of Akpatok Island. The Western Assessment Zone is dominated by *P. montagui* with *P. borealis* constituting 25% of the total *Pandalus* biomass. The three surveys conducted in the assessment zone indicate that the *P. borealis* biomass has changed little. The reference points established at this ZAP place the resource in the Healthy Zone of the PA framework (Fig. 14). The 1,500 t TAC established for the Western Assessment Zone for the 2013/14 fishing season will increase the potential exploitation rate to 8% if the biomass observed in the 2011 survey remains the same in 2013.

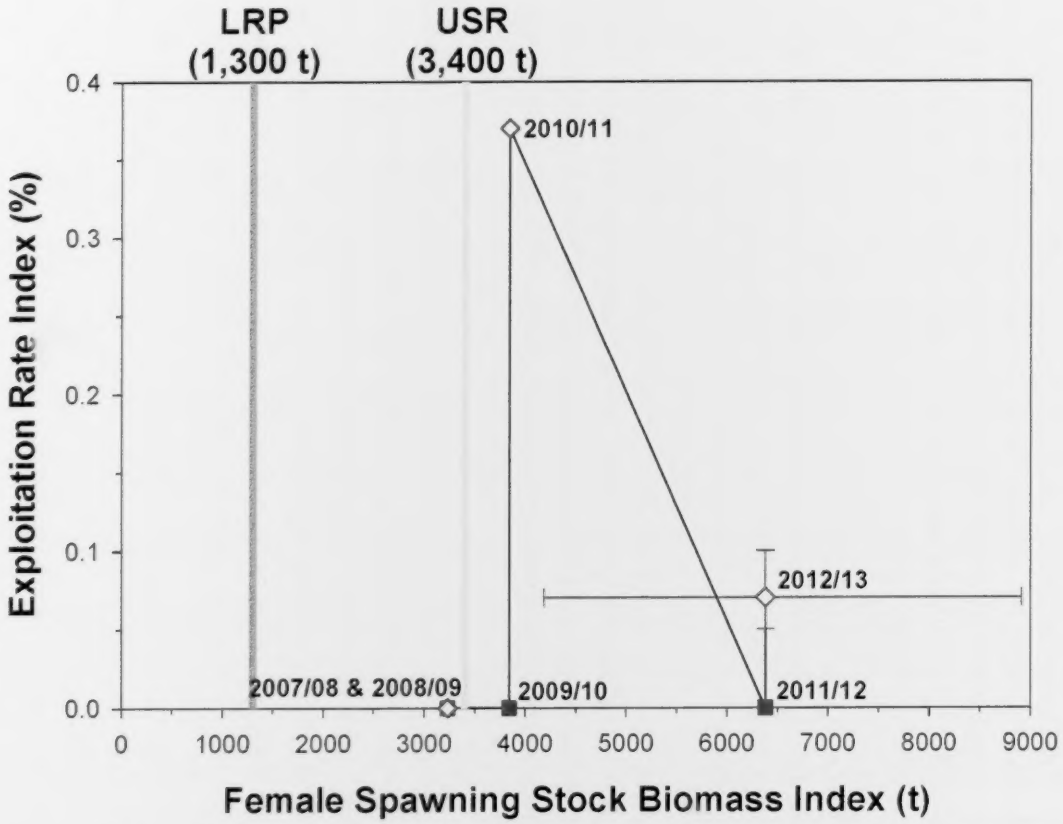

Figure 14. Western Assessment Zone trajectory of Pandalus borealis female spawning stock biomass index and exploitation rate index in reference to provisional limit reference points calculated using the proxy developed at two CSAS workshops in 2009. USR=Upper stock reference and LRP=limit reference point referring to 80% and 30% respectively of the geometric mean of the female spawning stock biomass indices from the 2007, 2009, and 2011 surveys. Since the area is surveyed biennially, exploitation rates from years without a survey (open diamond) were calculated assuming the population had not changed from the survey conducted the previous year (i.e., using the biomass from the previous year).

Western Assessment Zone – *P. montagui*

Fishery

The Western Assessment Zone was not fished between 1991 and 2010/11. The 2007, 2009 and 2011 research survey results renewed interest in fishing the area. The fishing took place in Hudson Strait near the land claims border north of Akpatok Island. Observer records show that there were catches of 300 t in 2010/11, 840 t in 2011/12 and 1,300 t in 2012/13.

CPUE for directed *P. montagui* fishing has increased significantly over the last three fishing seasons (Fig. 15). This is most likely due to captains learning where to fish in the zone rather than a reflection of resource status.

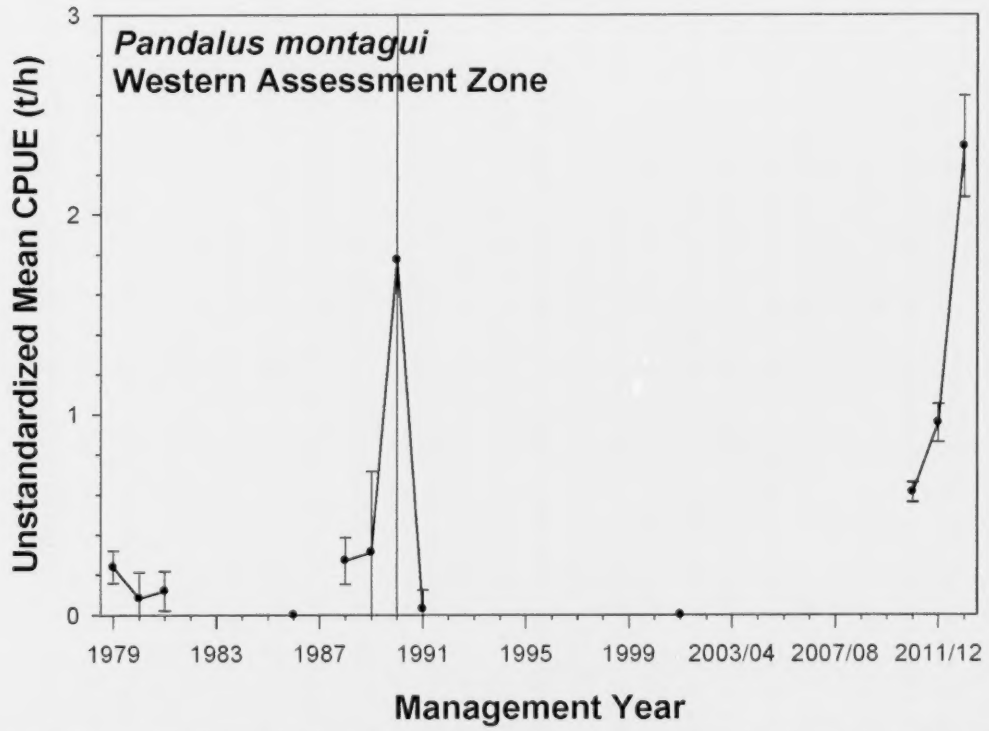

Figure 15. The unstandardized CPUE index for directed Pandalus montagui fishing in the Western Assessment Zone. Observer records for 2012/13 season may be incomplete. Error bars are 95% confidence ranges.

Biomass

The fishable biomass and SSB indices have not changed significantly among the three years surveyed (Fig. 16). The mean fishable biomass index for the three surveys was about 57,400 t, while the mean SSB index was about 23,300 t. In 2011, the fishable biomass index was 71,500 t and the SSB index was 32,500 t. There was no survey in 2012.

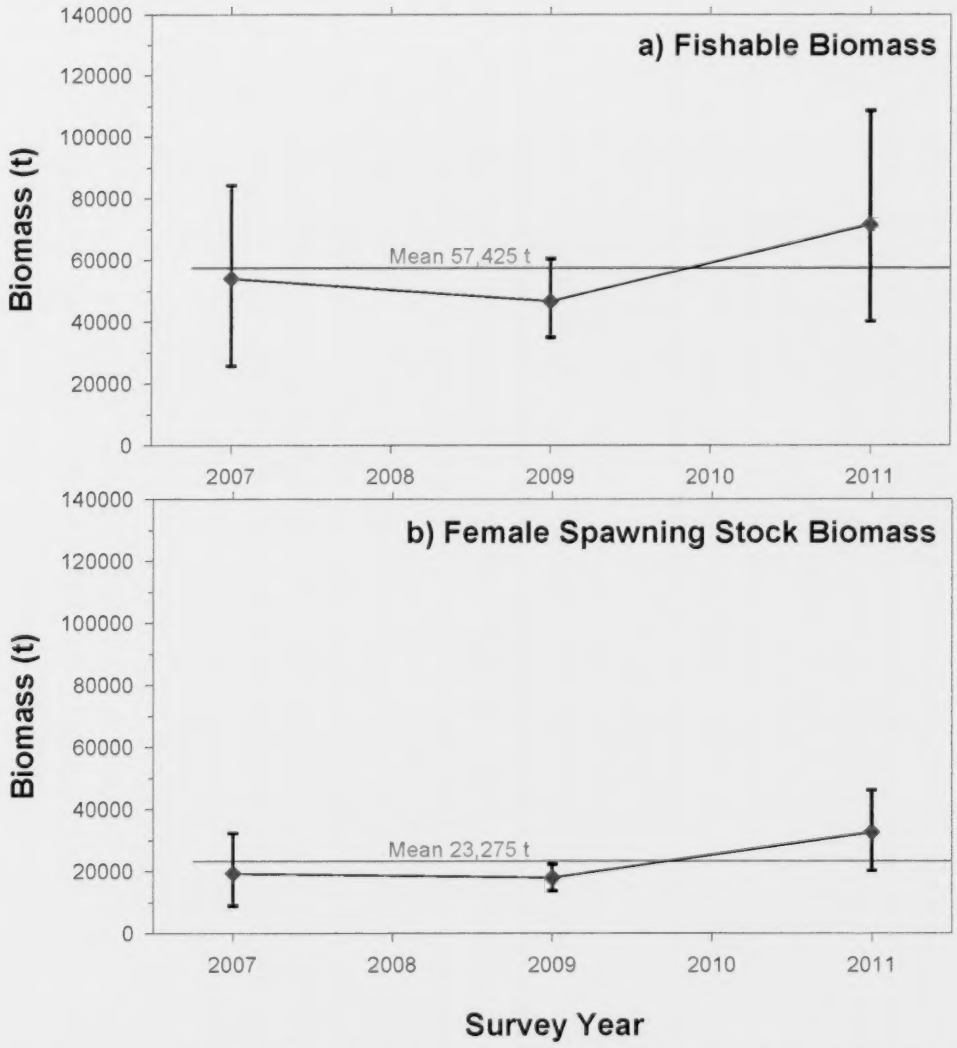

Figure 16. Western Assessment Zone Pandalus montagui, a) fishable biomass and b) female spawning stock biomass indices for the three years of DFO surveys. Error bars are 95% confidence ranges.

Exploitation

The exploitation rate was less than 2% from 2010/11-2012/13 (Fig.17). If the entire TAC was taken in the Western Assessment Zone it would also result in an exploitation rate of less than 2%.

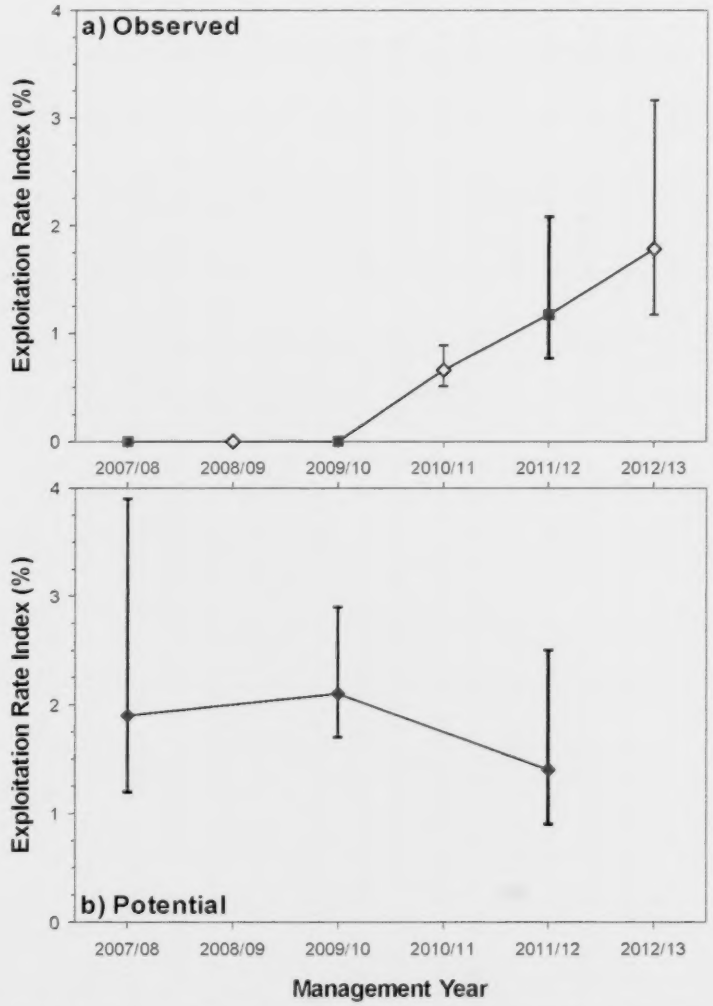

Figure 17. The Western Assessment Zone Pandalus montagui exploitation rate indices for the a) reported rate, based on the catch taken and the b) potential rate if the TAC was taken. Surveys in the Western Assessment Zone are biennial therefore biomass in intervening years was assumed to be unchanged from the previous year's survey estimate. Blue square indicates catch divided by biomass estimate in same year. Open diamonds indicates catch divided by biomass estimate from previous year. Error bars represent 95% confidence range.

Current Outlook and Prospects

The *P. montagui* resource has changed little based on the results of the three surveys conducted to date. Reference points were calculated for the Precautionary Approach framework (Fig. 18). Upper Stock Reference (18,000 t) was defined as 80% and the Limit Reference Point

(6,700 t) was defined as 30% of the geometric mean of the spawning stock biomass for the three surveys. These will be re-evaluated when additional data become available.

The SSB in 2011 is above the USR within the Healthy Zone of the PA framework established at this ZAP. The 5,000 t TAC established for the Western Assessment for the 2013/14 fishing season will increase the potential exploitation rate to 8% if the biomass observed in the 2011 survey remains the same in 2013.

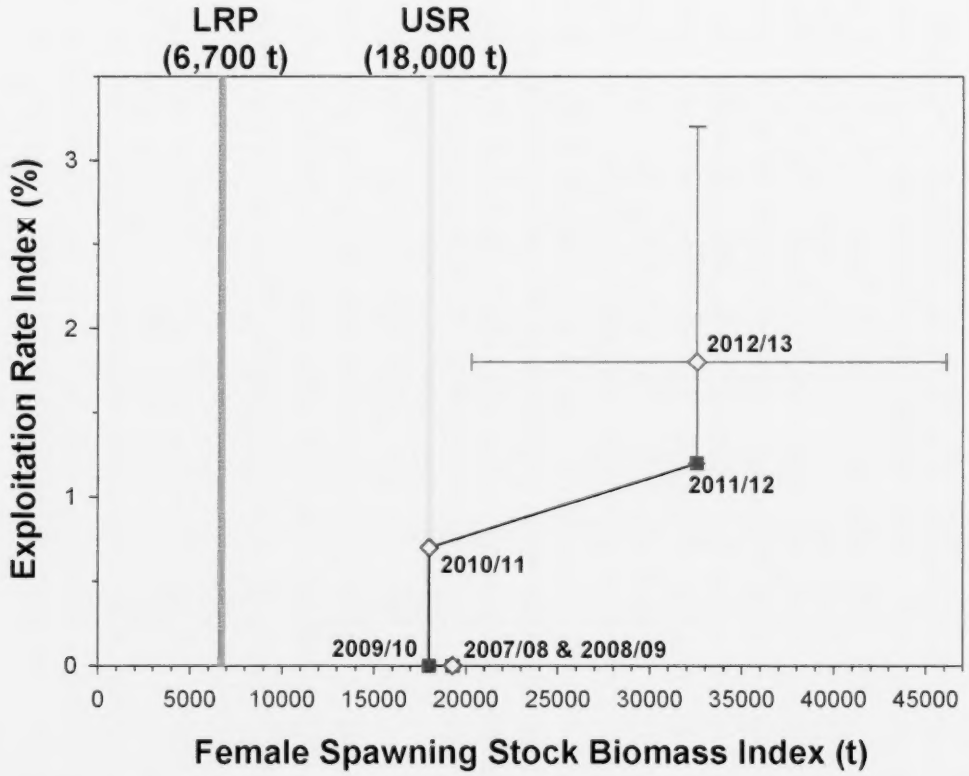

Figure 18. Western Assessment Zone trajectory of Pandalus montagui female spawning stock and exploitation rate in reference to provisional limit reference points calculated using the proxy developed at two CSAS workshops in 2009. USR=Upper stock reference and LRP=limit reference point referring to 80% and 30% respectively of the geometric mean of the female spawning stock biomass indices from the 2007, 2009, and 2011 surveys. Since the area is surveyed biennially, exploitation rates from years without a survey (open diamond) were calculated assuming the population had not changed from the survey conducted the previous year.

Sources of Uncertainty

Eastern and Western Assessment Zones

Hudson Strait is a highly dynamic system with strong tidal currents and mixing. Shrimp could be transported great distances in a relatively short period of time. This could result in populations shifting rapidly across the assessment zones.

Experimental work done by DFO in 2007 in the Resolution Island area suggests that results may be affected by the tidal cycle. Surveys from 2006 – 2008 were all conducted at the height of the spring tide, while the 2009 – 2012 surveys were conducted at neap tides to minimize the

tidal effect. Regardless, the survey is conducted over a 24-hour period so strong tidal currents would still be present and may result in either an over- or underestimate of biomass.

Fishery-independent surveys are conducted annually in the Eastern Assessment Zone and biennially in the Western Assessment Zone. If there is seasonality in the distribution of shrimp and/or the catchability of the shrimp in the trawl, this could affect the assessment.

Trawls used in the surveys have shrimp catchability less than one but the exact value is unknown. Therefore, the survey underestimates biomass. Catch is known; however, the total fishery-induced mortality is unknown (landed catch plus incidental mortality from trawling). Exploitation rates are a relative index rather than absolute.

The validity of the PA stock reference points used in this assessment is questionable especially in the Eastern Assessment Zone. Results from only three surveys are included in each and it is uncertain how the biomass during the surveys relates to B_{MSY}. Reference points calculated for the Eastern Assessment Zone no longer correspond to the management area and the first two surveys are no longer considered comparable with the remainder of the time series.

The survey of the Eastern Assessment Zone had been conducted by the Cape Ballard from 2005 to 2011. In 2012, the Aqviq was used after the Cape Ballard became unserviceable. Following the survey it was determined that the survey protocol was not followed in that the warp ratio was shortened. While any resulting changes in wing spread are accounted for in swept area calculations, trawl catchability may have been affected so the effect this had on the survey results are ultimately unknown.

CONCLUSIONS AND ADVICE

Eastern Assessment Zone – *P. borealis*

The current status of this resource is considered healthy based on the PA framework. Based on the 2012/13 TAC of 9,150 t the potential exploitation rate was 16%.

Eastern Assessment Zone – *P. montagui*

The resource in the Eastern Assessment Zone had been declining in the Cautious Zone and approaching the Limit Reference Point in 2011/12. Although the sharp increase in the SSB index in 2012 has moved it back into the Healthy Zone well above the Upper Stock Reference, concerns about the biomass estimate suggest caution. Based on a 2013/14 TAC of 2,250 t the potential exploitation rate would be 8% if the biomass remains the same as in 2012/13

Western Assessment Zone – *P. borealis*

The current status of this resource is considered healthy based on the PA framework. Based on the 2013/14 TAC of 1,500 t the potential exploitation rate would be 8% if the biomass remains the same as in 2012/13.

Western Assessment Zone – *P. montagui*

The current status of this resource is considered healthy based on the PA framework. Based on the 2013/14 TAC of 5,000 t the potential exploitation rate would be 7% if the biomass remains the same as in 2012/13.

MANAGEMENT CONSIDERATIONS

In general, management of key forage species, such as shrimp, under an ecosystem approach requires adoption of a more conservative approach with lower fishing mortality reference points and higher biomass reference points than those that would be adopted under a single species management approach. Keeping the exploitation rate at or below the base target of 15% for the Healthy Zone of the PA framework is thought to be conservative and leaves forage in the water for predators.

Reference points in the IFMP were based on different zones than are currently being assessed so the biomass levels used to define the reference points may no longer be appropriate. In addition, the survey time series that were used to determine the reference points are much shorter than in other SFAs. For the Eastern Assessment Zone, in particular, the time series included two years of data now not considered comparable with the rest of the series. The IFMP reference points should be adjusted to account for these concerns. Furthermore, some consideration, both by Science and RM, should be given to the minimum time series required to set appropriate reference points and when reference points should be revaluated.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 18-20, 2013 2013 Assessment of Northern and Striped Shrimp. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2006. A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

DFO. 2007a. Assessment Framework for Northern Shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland; 28-30 May 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/034.

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DFO. 2009. Proceedings of the Precautionary Approach workshop on shrimp and prawn stocks and fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

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DFO. 2012. Monitoring update for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the western and eastern assessment zones (SFA 2 and 3). DFO Can. Sci. Advis. Sec. Sci. Resp. 2012/001.

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Aussi disponible en français :

*MPO. 2013. Évaluation des stocks de crevettes nordiques (*Pandalus borealis*) et de crevettes ésopes (*Pandalus montagui*) dans les zones d'évaluation est et ouest (zones de pêche à la crevette 2 et 3). Secr. can. de consult. sci. du MPO, Avis sci. 2013/031.*